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HYDRODYNAMICALLY BALANCED AND RETRACTABLE RUDDER FOR SMALL BOATS

RELATED APPLICATIONS

[0001] The present invention claims the benefit of U.S. Provisional Patent Application Serial No. 06/492,034 filed on August 1, 2003 entitled "HYDRODYNAMICALLY BALANCED AND RETRACTABLE RUDDER FOR SMALL BOATS", which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates generally to deck retractable rudders for small boats, and more specifically, to a hydrodynamically balanced and fully retractable rudder for small boats. The present invention enhances performance of small boat (e.g., kayaks, small sailing craft, canoes and similar craft) by providing a high power, low drag, and low input force mechanism to aid control performance.

RELEVANT BACKGROUND

[0003] Retractable rudders have been in use with small boats, particularly kayaks, for years. Typically, retractable rudders include fully retractable rudders, partially retractable rudders, with variations including spring loaded rudders, and cam wheel rudders. A rudder is a generally flat or foil-shaped piece or structure attached vertically to the stern of a boat. In general, these rudders include a rudder assembly mounted to a hinge pin (also called a rudder pin) that enables the rudder blade to move from left to right in order to help control the boat's direction. Water flows across the rudder blade from a leading edge to a trailing edge. Pivoting the rudder blade about the rudder pin changes the angle of the rudder blade with respect to the water flow, thereby producing horizontal forces that work to steer the boat. Rudder blades are made retractable, commonly, by attaching the rudder blade to the rudder assembly via an axle pin and which is also the axis for pulley wheels around which torsion controls (commonly ropes, cables or lines) are engaged to raise and lower the blade about the pulley wheel and rudder blade's retraction pivot axis. An example of a partially retractable rudder system is shown in U.S. Patent 6,739,276 which is incorporated herein by reference. In the system

shown in U.S. Patent 6,739,276 the rudder blade retracts out of the water, but does not fully retract to the boat deck and so extends upward outside of the boat hull when "stowed".

[0004] A significant problem with conventional deck retractable rudders for small boats is that they are positioned fully to the rear side of the rudder's hinge pin (i.e., unbalanced), causing dynamic effects that increase the effort required to operate the rudder. The rudder system shown in U.S. Patent 6,739,276 is an unbalanced rudder in which the leading edge is positioned aft of the pivot mechanism used to operate the rudder. Operators overcome these dynamic effects by applying considerable force and attention to the rudder position. Alternatively, locking mechanisms (like trim tabs) may be desired on unbalanced rudders to steer with a rudder over long passages. On long passages a boater may need to run with the rudder set off center for long distances and experience the undesirable self-centering oppositional torque created by the rudder's extension to the rear of the rudder pin. The further the rudder extends behind the hinge pin the greater the self centering force that must be resisted.

[0005] A 'balanced rudder' refers to a rudder in which the leading

edge is forward of its pivot point. A balanced rudder requires less effort to steer as compared to an unbalanced rudder. Essentially, the pivot axis is located closer to or at the 'hydrodynamic center' (wide point of the foil) of the rudder blade, a position which, when turned, projects the trailing edge of the rudder blade to the 'normal' (aka unbalanced) side of the rudder pin and at the same time projects the leading edge of the rudder blade to the opposite side creating a balanced 'torque' effect. This greatly reduces the 'self centering' force which an unbalanced rudder creates. Of equal benefit, this different projection of the leading edge means that the leading edge enters undisturbed laminar flow that follows the hull of an untransomed boat (like most kayaks and canoes), greatly increasing the 'sideward' lift of the rudder blade in contrast to the same blade (in an unbalanced configuration) dangling on the opposite side of the rudder pin in disturbed, non-laminar flow. These gains are not available to existing retractable rudders. Unfortunately, in the field of conventional rudders for small boats balanced rudders are not retractable, and small boat 'retractable' rudders are not balanced. Retractability is common in small boat rudders because of the need to raise the rudder out of the

water, ideally to the boat's deck, in shallow water and remains a critical component to this invention.

[0006] Another problem with conventional deck retractable rudders for small boats is that rudders have a tendency to lift up, rotating backwards, while under speed because of the drag force exerted upon them by the boat's movement through the water. Further, rear mounted rudders tend to 'rise' out the water in wave action because rudders typically extend behind the boat, this lever lift effect on the rudder being amplified particularly as the boat passes over waves raising the boats tail extremely as the boats center of balance passes a wave top and starts a new descent). This situation is exacerbated by unbalanced rudders not 'wrapping' under the rudder hinge to operate more forward under the tail hull rather than behind it. The former problem of rotating backwards creates additional longitudinal 'torquing' force on the rudder, and thus more control force is needed by the operator to steer the rudder. The later problem reduces the amount of control the rudder exerts in steering the boat because the rudder itself engages less with the water with which it creates force.

[0007] While conventional devices may be suitable for the partic-

ular purpose to which they address, they are not as suitable for creating a device that enhances small boat performance (kayaks, small sailing craft, canoes and similar craft) which provides a high turning power, low drag, and low input force mechanism to aid control performance of small boats.

[0008] Accordingly, a need exists for a hydrodynamically balanced and fully retractable rudder for small boats. More specifically, there is a need for a device that enhances small boat performance (kayaks, small sailing craft, canoes and similar craft) which provides a high power, low drag, and low input force mechanism to aid control performance of small boats.

SUMMARY OF THE INVENTION

[0009] Briefly stated, the present invention involves a hydrodynamically balanced rudder that is fully retractable (i.e., where a leading edge of the rudder is positioned forward of an axis point about which the rudder is operated to steer when the rudder is positioned in water). The present invention further involves a rudder assembly and system for mounting a rudder assembly on a water craft such as a kayak or sailboat in which a rudder blade is held in a hydrodynamically balanced position when deployed and can

be fully retracted into the water craft when in a stowed position. The present invention also involves methods of making and operating a fully retractable, hydrodynamically balanced rudder and rudder assembly.

[0010] In view of the foregoing disadvantages inherent in the known types of deck retractable rudders for small boats now present in the prior art, the present invention provides a new hydrodynamically balanced and fully retractable rudder for small boats which enhances performance of small boats (kayaks, small sailing craft, canoes and similar craft). The present invention provides a high power, low drag, and low input force mechanism to aid control performance of small boats. A unique cantilevered shape' ', retractable rudder blade is provided that is able to travel from the deck or other stowed position of the boat to the underside, generally rear of the boat. When in the deployed position, the rudder blade aligns under with the hinge pin of the rudder providing a leading edge of the rudder blade which pivots opposite the trailing edge of the same rudder blade. . In the deployed position the rudder blade aligns under the hinge pin of the rudder providing a generally 'balanced' rudder effect, with the shaft of the hinge preferably mating to the wide section of

the foil that comprises the rudder's most effective cross section.

[0011] A significant purpose of the present invention is to provide a new hydrodynamically balanced and fully retractable rudder for small boats that has many of the advantages of the deck retractable rudders for small boats mentioned heretofore and many novel features that result in a new hydrodynamically balanced and fully retractable rudder for small boats which is not anticipated, rendered obvious, suggested, or even implied by any of the prior art deck retractable rudders for small boats, either alone or in any combination thereof.

[0012] It should be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or illustrations.

[0013] Other objects and advantages of the present invention will become obvious to the reader and it is intended that these objects and advantages are within the scope of the present invention.

[0014] To the accomplishment of the above and related objects, this invention may be embodied in the form illustrated in the accompanying drawings, attention being called to the

fact, however, that the drawings are illustrative only, and that changes may be made in the specific construction illustrated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Various other objects, features and attendant advantages of the present invention will become fully appreciated as the same becomes better understood when considered in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the several views, and wherein:

[0016] FIG.1 shows a rudder assembly in accordance with the present invention mounted to a kayak in a stowed position;

[0017] FIG.2 shows a rudder assembly in accordance with the present invention in a swinging position;

[0018] FIG.3 shows a rudder assembly in accordance with the present invention in a deployed position;

[0019] FIG. 4 through FIG. 8 illustrate several views of an implementation of the present; and

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] The balanced wing rudder in accordance with the present invention differs from existing retractable rudders in one

critical point: the rudder hinge (pivot axis) of the rudder is substantially aligned with the wide point of its 'wing' foiled shape. This balancing creates off setting forces (torque) meaning that the piloted boat can be directed with extremely low amounts of toe pressure. Moreover, the balanced effect projects the leading edge of the rudder blade to the opposite side vis-à-vis the leading edge of an unbalanced rudder, exposing it to the 'clean laminar' flow that follows the hull of the boat towards the stern of the boat. Unbalanced rudders must work in either disturbed 'wake' water more further aft, or minimally, must interface with water traveling much more in opposition to the flow lines of the rudder blade itself, and create much more drag accordingly. Remarkably, this extremely efficient tapered foil interfacing with laminar flow creates so little 'drag' force that the presence of the rudder can almost not be felt as a slowing effect by even the most experienced paddlers. In the extremes of its movement the rudder blade is fully retractable to a mount soft V-block on the deck, and in the other extreme to an engaged position to a setting snap which fixes the blade to an efficient and effective under boat position that is forward of the gravitational hang line of the rudder blade itself.

[0021] The present invention enhances performance of small boat (e.g., kayaks, small sailing craft, canoes and similar craft) by providing a high power, low drag, and low input force mechanism to aid control performance. By creating a particularly cantilevered shape , retractable rudder blade which can travel from the deck or other stowed position to the underside, generally rear of the boat, and align under with the hinge pin of the rudder, the present invention provides a fully 'balanced' rudder effect. The shaft of the hinge mates ideally to the wide section of the foil that comprises the rudder's most effective cross section.

[0022] As shown in Fig. 1, a rudder assembly 100 in accordance with the present invention generally comprises a cantilevered rudder blade 101, rudder retraction pulley 102 and retraction axle pivot 103, control plates 104 and a hinge core 107. The components can be manufactured from molded or machined plastic or otherwise specifically shaped suitable material. The hinge core 107 comprises a molded or machined structure integrating a rudder pin receptacle 105 best visible in Fig. 3. The pin receptacle 105 is used to attach to the intended boat's rudder mount 113. A rudder pin 106 provides a hinged attachment to the rudder mount 113. The hinge core 107 either attaches

to or is integrally formed with the control plate structure 104. A housing is formed by the combination of hinge core 107, control plates 104, and the rudder retraction pulley 102 such that the housing bridges and hold in parallel the cantilevered rudder blade 101.

[0023] In operation, a control line 110, shown in Fig. 2, passes around pulley 102 and attaches to rudder blade 101. The two free ends of the control line 110 are operated from inside the boat such that pulling one free end causes rudder blade 101 to lower by pivoting about axle pivot 103 while pulling on the other free end of control line 110 causes rudder blade 101 to raise from a deployed position (shown in Fig. 7) to a stowed position as shown in Fig. 1. The arc in Fig. 1 with double arrows illustrates the direction of motion about axle pivot 103 caused by operation of the control line 110.

[0024] A 'snap feature' is preferably implemented by a shaped groove 402 and complementary ridge pattern 401 visible in Fig. 4 between rudder blade 101 and hinge core 107. The snap feature functions to frictionally engage the rudder to hold it in position while in the water (i.e., when the rudder 101 is extended in the down position). The frictional engagement is such that the rudder blade 101 can

be disengaged from the groove 401 when it is desired to retract the rudder blade 101. Once the snap feature is engaged, the rudder blade 101 is mechanically constrained at multiple locations (e.g., constrained both by axle pivot 103 and by the interaction of ridge/groove 401/402) along the length of rudder blade 101 which inhibits "swimming" motion in both port-starboard motion as well as fore-aft motion. The snap feature shown in Fig. 4 may be replaced by a cam cleat on the control lines, 110 below, to stabilize the rudder, however, the snap-in frictional engagement provides superior performance.

[0025] The rudder blade 101 is configured as a somewhat boomerang-shaped structure as shown. In a particular example, rudder blade 101 is integrated with a 'axle' hole (103) and pulley wheel 109 that is either molded or directly mated via an axle bolt or equivalent fastening device that allows pulley wheel 109 to rotate such that rudder blade 101 is clear of water in operation (e.g., at least 90 degrees), and more preferably more than 180 degrees and most preferably about 270 degrees such that rudder blade 101 can be fully retracted and can be stowed in a position that is attached to the boat hull.

[0026] Through the application of torque applied through a rud-

der raising control line 110, the blade 101 is moved from a down position (i.e. a deployed position shown in Fig. 3), in the water, approximately 270 degrees or more to the up position (i.e., a stowed position shown in Fig. 1) lying on the deck of the boat. In a specific embodiment, the rudder blade 101, particularly includes a 'step' feature 111, which projects the forward edge 112 of the rudder while in the down position shown in Fig. 3, under the rudder's hinge pin 106. This cantilevered arrangement creates a 'balanced' rudder effect by placing the 'hydrodynamic center' (or equivalent) of rudder blade 101 near to, and desirably aligned with, the hinge pin 106. Leading edge 112 projects to one side (e.g., the front side) of the boat being controlled with respect to hinge pin 106, and the rudder's trailing edge projecting to the other side (e.g., the back side) with respect to hinge pin 106 and the hydrodynamic center of rudder blade 101.

[0027] Although it is preferred that the hydrodynamic center of rudder blade 101 is substantially aligned with the rudder pin 106, the balanced rudder effect (and therefore substantial performance improvements) are achieved whenever the leading edge 112 is forward of hinge pin 106. Step feature 111 tends visibly apparent to be visibly ap-

parent in implementations of the present invention, however, it is contemplated that the step 111 can be smoothed to the point that it is no longer visibly apparent as a step while at the same time causing leading edge 112 to be positioned forward of the hinge pin 106, and therefore achieve a similar function according to the present invention. Implementations of the present invention are characterized by the combination of the leading edge 112 being forward of the axis about which the rudder is pivoted in operation (e.g., hinge pin 106) together with a fully retractable design that allows rudder blade 101 to be retracted clear of the water and preferably into the boat in a position that is attached to the boat hull (e.g., the boat deck as shown in Fig. 1).

[0028] The rudder blade 101 may be made from a durable generally stiff material, or may be made from various more 'elastic' materials which would facilitate either twisting of the rudder blade 101 through its length, or whipping of the rudder blade 101 in an alternative mode creating an actual propulsive force, akin to a fish tail. The rudder assembly 100 may include either integrated or separable pulley wheels. The profile (in side view) of the rudder blade 101 may take a 'spade' shape, boomerang shape, or

a more rectangular shape, and may also be designed to include one or several crosswise wings (not shown) which could be designed to provide either lifting, or sinking force. The hinge core is designed to provide male or female hinge component that mates with the small boats 'gudgeon' or 'rudder mount. The shape is distinctive in that it indicates a portion of the rudder blade exists both fore and aft of rudder pin 106 and therefor indicates a balanced rudder. The present invention is particularly identified by the combination of a balanced rudder and that is configured to pivot such that the rudder can be completely removed from the water and more particularly pivoted at least 270 degrees so that the rudder can be stowed securely in or on the boat. A pin 106 passes through the two parts 113 and 107 via the hinge pin and receptacle 105 to provide the hinging action allowing the rudder 101 to pivot on this pin in the application of its hydrodynamic force.

[0029] The hinge core 107 is designed, in a particular implementation, as a stand alone piece which is wrapped by the Control plates, or can be combined, typically via molding or machining or other form of fastening, to provide an 'A-B' sandwich enveloping the rudder control pin from the

stern port and starboard sides of the boat. Other construction techniques are also possible which could combine the control plates 104 and rudder core 107 into one unit.

[0030] In Fig. 5 through Fig. 8 an implementation of the rudder assembly 100 is shown without a boat to allow a clearer view of the assembly 100 itself. In many cases a rudder assembly 100 is marketed and sold separately from any particular boat. Fig. 5 illustrates another view of an implementation of a rudder assembly in accordance with the present invention in a stowed position. Fig. 6 illustrates a view of an implementation of a rudder assembly in accordance with the present invention in a partially stowed position in which the rudder blade is rotated about axle pivot 103 by 180 from its deployed or in-water position. Fig. 7 illustrates another view of an implementation of a rudder assembly in accordance with the present invention in a deployed or in-water position. Fig. 8 illustrates another view of an implementation of a rudder assembly in accordance with the present invention in a partially deployed position at about 90 degrees from the in-water position.

[0031] With respect to the above description then, the optimum

dimensional relationships for the parts of the invention, to include variations in size, materials, shape, form, function and manner of operation, assembly and use, are deemed readily apparent and obvious to one skilled in the art, and all equivalent relationships to those illustrated in the drawings and described in the specification are intended to be encompassed by the present invention. Therefore, the foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

[0032] Although the invention has been described and illustrated with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example, and that numerous changes in the combination and arrangement of parts can be resorted to by those skilled in the art without departing from the spirit and scope of the invention, as hereinafter claimed.